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Sustaining the Fleet

NAVAL SURFACE WARFARE CENTER

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Sustaining Today's Fleet Efficiently and Effectively

By Captain Mark W. Thomas, C. Randy Reeves, and Captain Alexander S. Desroches

The Naval Sea Systems Command (NAVSEA), in support of the Secretary of the Navy (SECNAV) and Chief of Naval Operations (CNO), is specifically aimed at bringing the 313-ship Navy from concept to reality.

With the defense budget already strained, Navy recapitalization dollars split between ships and aviation, and acquisition programs over cost and schedule, the Navy is challenged to meet our 313-ship goal, which in turn impacts our ability to continue to be the dominant and most influential naval force.

When he assumed command of NAVSEA, Vice Admiral Kevin M. McCoy challenged the command's headquarters and field activities, including Carderock Division, to focus on the NAVSEA Strategic Business Plan goals:

-Sustaining today's fleet efficiently and effectively.
-Building an affordable future fleet.
-Enabling our people.

Vice Adm. McCoy emphasized the key to meeting the 313-ship goal is maintenance, the sustaining of today's fleet portion, because we could never meet that goal through acquisition alone. An example of how the current fleet is challenged is the DDG 51 Class. This class was designed for a 30-year life. Due to funding constraints, those ships have not been maintained at a level to meet that life span. Additionally, the Navy now wants that class to be in service for 35 to 40 years, instead of 30. Decreased funding resulted in deferral of the fiscal year 2010 DDG 51 Class docking availabilities. The maintenance issues don't focus solely on this class of ship. On the submarine side of the house, maintenance availabilities for the 688 Class subs are taking too long. Ships in the fleet routinely forego routine maintenance to focus on what "must" be done.

Engineering is crucial to sustaining the current fleet. "Maintenance" is part of Carderock Division's life cycle mission. As the Navy's full spectrum provider of naval architecture and marine engineering, we provide responsive, innovative, and cost-effective technical solutions to the warfighter. "Engineering in" smarter technology can add to the life of systems and ships.

Recent examples of how Carderock Division is working to sustain the fleet include:

- Serving as subject matter expert to the Safety Investigation Board regarding the fire investigation on *USS George Washington* (CVN 73). Over a five-week period, Carderock Division provided key technical support in the areas of fire forensics, as well as onsite support for assessments, data gathering, interviews, analysis, and the development of the preliminary report and recommendations.

- Providing equipment health monitoring and condition-based maintenance through the use of the Integrated Condition Assessment System and Integrated Performance Analysis Reports. This approach is saving the Navy $3.3 million per year for gas turbine generators alone.

- Designing, testing, and deploying stern flaps, which have been installed on 159 Navy and U.S. Coast Guard ships, collectively. Stern flaps help reduce cost, reduce transit time, increase payload, and increase the interval between engine maintenance or reconfiguration. To date, stern flap use has saved more than $300 million in fuel costs.

SUSTAINING TODAY'S FLEET (Continued on page 2)

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The SEAFRAME staff reserves the right to edit or rewrite all submissions.

On the cover: A U.S. Navy small boat comes alongside the amphibious assault ship *USS Kearsarge* (LHD 3) to transfer personnel and equipment while underway in the Persian Gulf. *Kearsarge* and embarked 26th Marine Expeditionary Unit are on a scheduled deployment in support of the war on terror and are currently conducting Maritime Security Operations in the Persian Gulf.
U.S. Navy photo.
Cover design by Gloria Patterson, NSWC Carderock Division.

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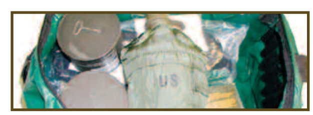

TECHNOLOGY AND INNOVATION

FROM THE TOP

SUSTAINING TODAY'S FLEET (Continued from inside cover)

- Developing advanced blade section design technology for propulsors that reduces cavitation damage and required repair cost and time.

- Conducting acoustic trials, crew training, and at-sea tech assists to ensure the Navy's deploying submarines and their crews maintain an acoustic stealth advantage over their adversaries.

- Providing shipboard plastics waste processors which reduce maintenance requirements by 60 percent, reduce waste processing time in half, and lower the number of parts in the machines by more than 30 percent, making it simpler to operate and maintain. In FY 08, 10 initial installations were accomplished.

- Replacing aging Central Atmosphere Monitoring System Mk I submarine atmosphere analyzers on SSN 688 Class with upgraded CAMS Mk IIA, an improvement that features a mass spectrometer module ($100K per overhaul) life extension from three to 10 years.

- Performing detailed HM&E surveys, developing detailed specification packages, providing on-site support for scheduled overhauls, leading all in-service engineering efforts, and installing advanced technologies on Mk V Special Operations Craft located stateside as well as deployed around the world. The craft continue to exhibit an average 98 percent mission reliability, even as some approach the end of their estimated life span.

- Re-designing inadequate dry deck shelter and advanced seal delivery system composite components that were prematurely failing, predicted to not meet full performance life, or had high likelihood of damage with no replacements in the inventory. The design of the DDS composite fairing shipsets used new material, an innovative fabrication process, and blueprint that resulted in structures having 50 percent to 60 percent increase in both stiffness and strength.

- Replacing submarine oxygen generators on *Seawolf*, SSBN, and SSGN classes with technology employed on the *Virginia* Class. This technology, the low pressure electrolyzer, makes oxygen at ambient pressure, which is far less costly than the earlier high pressure systems.

Carderock Division supports our Navy's missions with its unparalleled expertise in ships and ship systems. Our services range from theory and conception through design and acquisition to fleet insertion and in-service engineering. Carderock Division has a proven record of success in providing the Navy with advanced technologies for ships and ship systems, as well as timely solutions to critical engineering problems.

In some way, at some time, the Carderock Division has touched every ship in the fleet today. This issue of SEAFRAME focuses on specific efforts which are sustaining today's fleet efficiently and effectively. "Sustaining today's fleet is essential in achieving a 313-ship Navy," said Vice Adm. McCoy.

FAREWELL TO MANAGING EDITOR

We mourn the sudden loss of Leslie Renee Spaulding, the managing editor of SEAFRAME magazine.

Leslie graduated from Glassboro State College (Rowan University) with a Bachelor and Master's degree in Public Relations. She began her career at Naval Ship Systems Engineering Station (NAVSSES) in December 1985, in the Heat Power Department, currently known as the Steam and Auxilary Systems Division. In 1987, she moved to the Technical Coordination/Public Affairs Office and took on a writing position. She was a renowned writer and editor of many Carderock Division publications and newsletters through the years.

Leslie died in her home on December 10, 2008. She was 45 years old. She is survived by her husband James "Jim" Spaulding, two daughters: Amanda and Emily, mother Gail Jenis, two brothers: Frank (Paula) and Scott (Melissa) Jenis, sister Bonnie (Bill) Markey, other relatives, and countless friends and coworkers.

Leslie spent her entire government career at NAVSSES doing what she liked to do – write. She will be sorely missed!

NEW PROCESS-BUSINESS MODEL

Carderock Division Adopts New Management System to Become More Efficient and Effective

By Leslie Spaulding

Naval Surface Warfare Center, Carderock Division (NSWCCD) implemented a new business model to integrate strategic leadership efforts with process improvement initiatives that will allow the organization to achieve the Department of Defense goal of being more effective and efficient and move closer to becoming the worldwide technical leader for naval architecture and marine engineering.

Called the Division Process Management System (DPMS), this approach brings together several initiatives that were formerly pursued as separate efforts. The DPMS provides key process management and accountability by fostering a process-oriented business model and building and sustaining a key process foundation. This approach will help to integrate and align NSWCCD's strategic planning, continuous process improvement, and performance assessment. Specifically, the DPMS will be used to implement the Division's Strategic Plan through Leadership Focus Teams (LFTs), and these LFTs will be coordinated via the DPMS. Under the DPMS, Carderock Division will conduct periodic performance assessments via the Naval Sea Systems Command's Performance and Compliance Inspection (NPCI)/Baldrige criteria, which provides a proven assessment tool and criteria for performance excellence.

The shift toward DPMS began with identifying 36 key processes within NSWCCD during the NPCI earlier this year. To make the list, the processes had to be critical to the Division's mission and long-term success and involve and impact a large portion of the Division's population. An example is workforce development, which involves the entire Division population through technical and professional development and impacts its ability to sustain its expertise. While this first phase was underway, the Division published its Strategic Plan, which outlined 17 objectives. Later, 10 additional key processes were identified. The combined 46 key processes and 17 strategic objectives under DPMS were aligned, categorized by leadership focus area, and then assigned to seven LFTs. These teams, which are led by members of the NSWCCD Board of Directors, consist of volunteers and assigned members that are a cross-representation of the Division's technical and business departments, as well as the individuals responsible for the key processes, known as key process owners. The seven LFTs are Assessment and Improvement, Communication, Customer Relationship, Infrastructure, Inter-Department Support, Technical Work, and Workforce. The LFT concept combines the Carderock Division leadership perspective, a cross-organizational point of view, and the "inside" knowledge of the key process owners in a collaborative environment.

While the LFTs are a large part of the DPMS, the approach also entails ongoing process management, assessment and continuous improvement, and supports the development and application of relevant process and organizational results metrics. NSWCCD is inspected every three years using the NPCI/Baldrige criteria. This same criteria will be used annually to achieve and sustain performance excellence.

NSWCCD, through the DPMS, has found a way to tie its separate management initiatives together: strategy, assessment, and improvement. By aligning these efforts, the Division can help sustain today's fleet more efficiently and effectively; help build an affordable future fleet; and enable its people, thus fulfilling NAVSEA's Strategic Business Plan goals.

DPMS logo by Gary Garvin, NSWC Carderock Division.

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Customer Advocacy

The Eyes of the Undersea Fleet

Customer Advocates Ensure Submarine Imaging System Support Works in Concert

By Leslie Spaulding

Known as the "Eyes from the Deep," submarine imaging systems, which include systems commonly referred to as periscopes, allow a submarine to search for both sea and air threats while the submarine remains submerged and undetected. While the Naval Undersea Warfare Center (NUWC) Newport is responsible for these systems and their associated electronics, engineers at the Naval Surface Warfare Center, Carderock Division-Ship Systems Engineering Station (NSWCCD-SSES) are responsible for the hull, mechanical, and electrical (HM&E) systems that mount, raise, lower and protect the imaging systems. As the Navy's periscope community is a small, tight-knit group of people and activities, good alignment and cooperation amongst the key players is paramount to ensuring ship's force can see the outside world whenever necessary. John Skutnik and Jim Classick are the customer advocates at NUWC and NSWC, respectively, who are working periscope systems and are closely networked in support of Captain Christopher Scofield of the Submarine Imaging and Electronic Warfare Program Office (NAVSEA PMS 435).

NSWCCD-SSES involvement with NUWC, NAVSEA, and submarine periscope systems extends back decades and is characterized by a broad, cooperative approach that focuses on the needs of the fleet. As outlined in formal memorandums of understanding with PMS 435, NSWCCD-SSES serves as the Navy's technical design agent, in-service engineering agent, and life cycle manager for the HM&E systems related to periscopes, while NUWC is similarly charged with these responsibilities for the periscopes and the associated electronics. While the lines of responsibility of each organization are clearly defined, there is a smooth flow of information and technical support across these lines whenever the need arises.

Former Submarine Sensor Systems Program Manager Captain Dave Duryea, who recently transitioned from the program, praised the customer advocate process as providing programmatic and technical expertise across a broad spectrum, including technical design, life cycle management, and fleet support. Duryea noted that the overall success of the Submarine Imaging and Electronic Warfare Program Office has been achieved with superb support from the customer advocacy teams in place at the Warfare Centers.

In addition to a submarine's imaging systems, NSWC has responsibility for HM&E systems throughout the sail that support all other sensor, navigation, and propulsion systems. These systems include radar systems, navigation ID, communication antennas, electronic warfare antennas, snorkel, and streaming wire antennas. Essentially, anything in a submarine sail that goes up and down or in and out involves the efforts and expertise of NSWC's engineers and technicians. As with periscopes, NSWC works closely with the Navy field activities and commands which hold responsibility for these sensors, all with a goal of seamless, end-to-end support to the fleet.

Carderock Division is also involved in new sail system design and integration, acquisition, installation, SUBSAFE certification, quality assurance certification, field change development, troubleshooting, integrated logistics support, maintenance planning, and even disposal at the end of a submarine's life cycle. NSWC also supports submarine sail systems as boats go through major overhaul and refurbishment by managing the overhaul and repair of the HM&E systems in the sail. To this end NSWCCD-SSES ensures the contracts are properly written from a technical standpoint and are properly executed by the manufacturer, providing knowledgeable,

This rendering depicts a submarine sail with its sensors up.
Rendering by Charles Dilger, NSWC Carderock Division.

The *USS Virginia* (SSN 774), pictured at left, is just one of the classes of submarines that will benefit from ongoing, planned upgrades to their imaging systems.
U.S. Navy photo.

experienced oversight for the repair, re-assembly, testing, and overall assurance of a quality overhaul.

Currently, the organization is involved in adapting a number of new sensors to submarines presently in service and in planning. In many cases the development of new sensors requires the submarine sail and associated HM&E systems be modified. This type of effort necessitates support across the engineering, acquisition, logistics, installation, and quality assurance communities. “We’re currently doing work for the *Virginia* Class, SSGN, and SSN submarines, looking at options for where and how to site these new sensors in order to provide flexibility to the submarine force and allow them to package a suite of sensors in the sail that will support specific missions,” explained Classick.

Because all systems in the submarine sail are so totally integrated, any modifications or changes to one part of the system can greatly impact another. To this end those individuals and activities which support the Navy’s submarine sensors must work in harmony. The customer advocacy structure ensures such a coordinated and concerted effort.

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Naval Expeditionary Combat Command

Carderock Division Supports NECC Small Craft Projects

By William Palmer

The Naval Expeditionary Combat Command (NECC) has been steadily supported by Naval Surface Warfare Center, Carderock Division. That support continues as Carderock’s Combatant Craft Division (CCD) in Norfolk, Va., is supplying an ongoing stream of personnel and equipment to bolster NECC’s role in the global war on terror. The current phase of the relationship between the two groups started in late 2006, when NECC

COMBAT COMMAND (Continued on page 6)

Above: A Riverine Command Boat (RCB), maneuvering during builder's trials in Port Orchard, Wash.

Top: A RCB during weapons and smoke system testing in the Strait of Juan de Fuca, Wash.

COMBAT COMMAND (Continued from page 5)

was stood up from the old Maritime Force Protection Command. The organization remained relatively intact, with a few new components and capabilities added.

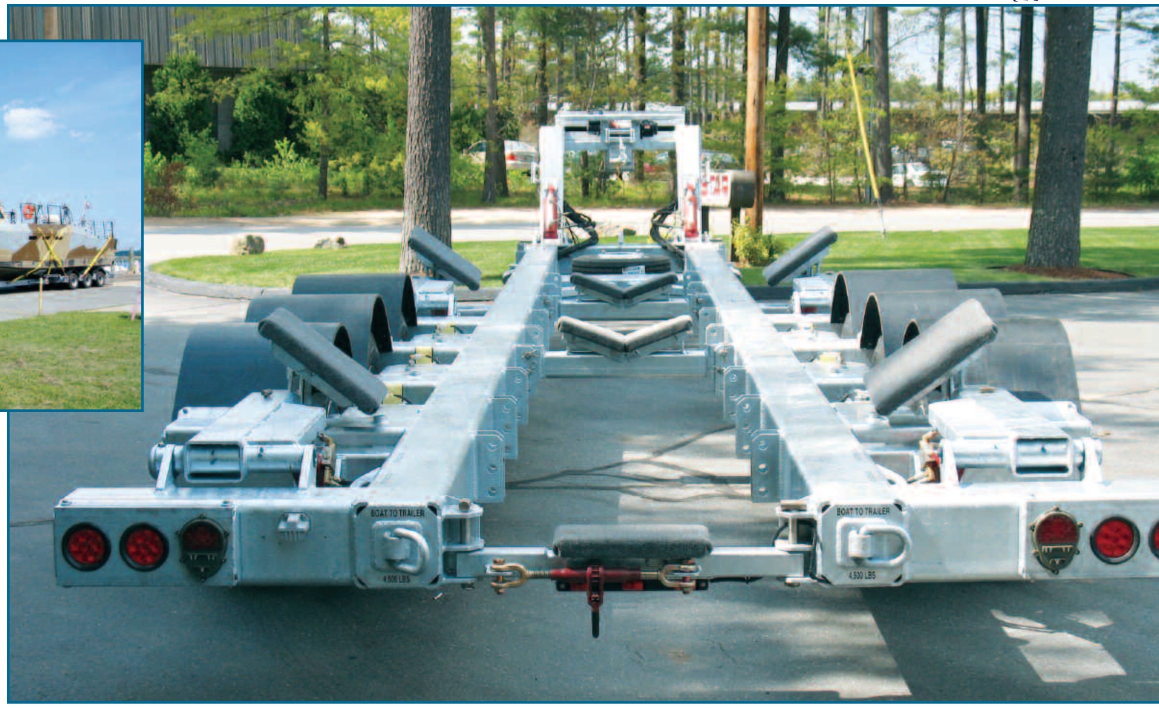
CCD's work is divided into three areas: Research and Development Science and Technology, Acquisition, and In-Service Engineering. These areas serve three subordinate commands within NECC: the Maritime Expeditionary Security Force (MESF); the new Riverine Group One; and the Explosive Ordinance Disposal, highly in demand in Iraq at present. Several projects are ongoing, among them the new Riverine Project, providing support for the Small Unit Riverine Craft (SURC). Major alterations were tackled when the project was stood up, such as an up-armor kit, a major command, control, communication, and computer intelligence surveillance and reconnaissance (C4ISR) upgrade, and development and fielding of the Rough Terrain-capable Boat Trailer. Lessons learned from the Marine Corps deployments into Iraq provided the basis for these changes.

Carderock employees had six months to prepare and modify the craft to meet the first squadron deployment. But it wasn't only the timeline that was challenging, says Jason Marshall, senior craft design manager in CCD's Naval Architecture branch, but also the volume of work. "At the same time we transitioned the SURC from the Marine Corps to the new USN Riverine squadrons," says Marshall, "we developed the configurations, designs,

Above: An 11-meter Rigid Inflatable Boat (RIB) with an up-armor kit for deployment.
Photos this page courtesy of Jason Marshall, NSWC Carderock Division.

kitting and installation of various mods for the trailer, armor, and C4ISR. Also, we had to procure additional interim platforms for the Navy, because the craft turned over from the Marines didn't have a sufficient life cycle or quantities to fully outfit all their squadrons. We were building new boats at the same time we were retrofitting old boats, and making the configurations match as much as possible. We were also seeking technology solutions to correct some deficiencies that had developed during the USMC deployment of the craft where off-the-shelf solutions did not exist."

But the Riverine project was not the only customer moving CCD at a rapid pace. The MESF, formerly known as the Naval Coastal Warfare command, wanted a rapid transformation of some of their force capabilities to the MESF, which encountered problems when recently-purchased boats–configured for a certain mission profile –were employed in the global war on terror, which incurred reliability issues. The CCD In Service Engineering



Above: A RCB on the first-article Hydraulic Boat Trailer, behind an MTVR Mk31 tractor at Aberdeen Test Center qualification tests.

Top: Two Rough Terrain trailers stacked for air shipment to Iraq.

Right: First-article Hydraulic Boat Trailer for the RCB.

Photos this page courtesy of Jason Marshall, NSWC Carderock Division.

Agent branch performed change-outs from outdrive main propulsion systems to waterjets. They're currently providing additional armor, communications, and stabilized weapon systems boat alterations and proof of concept testing.

CCD's level of support is not limited to Navy commands. They are also the Army's designated technical acquisition support agent for all Army watercraft. They liaison closely with the U.S. Coast Guard's acquisitions, providing support and lessons learned to that command as well. CCD performed the Response Boat–Medium test program for replacement designs for the 41-foot utility boats on behalf of the Coast Guard. And if you've ever attended the Multi-Agency Craft Conference, held yearly at the Naval Amphibious Base in Little Creek, Va., you would see almost all of CCD's customers.

Members of the CCD team have travelled to Iraq to support the installation of C4ISR upgrades and also serve as liaison for other boat issues that were outstanding. They are one example of the team, various members of which travel constantly in support of NECC work. Traditionally, team members involved with either design or in-service work travel to the boat construction companies or the operational commands that use them, and assist in troubleshooting issues encountered while the small craft are in construction, training, or are in-theater. Frequent visits to MESF units on the east coast and west coast also occur, and in-service engineers and technicians have made trips to Bahrain and Kuwait.

Marshall says it has been worth it, but it has not been easy. "I cannot emphasize enough," he says, "the large group of highly competent, highly motivated people and the Herculean effort it took to get this all coordinated. We had to coordinate with not just CCD personnel, but industry partners and other government agencies, and NAVSEA program offices. The effort it took to stand up the Riverine project in the short time that CNO requested it, and overlay the enhancements of MESF craft on top of that, was truly a major task."

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Hull Forms & Propulsors

Control Systems for Submarine Maneuvering

Carderock Division Maintains Fly-By-Wire Ship Control Systems

By William Palmer

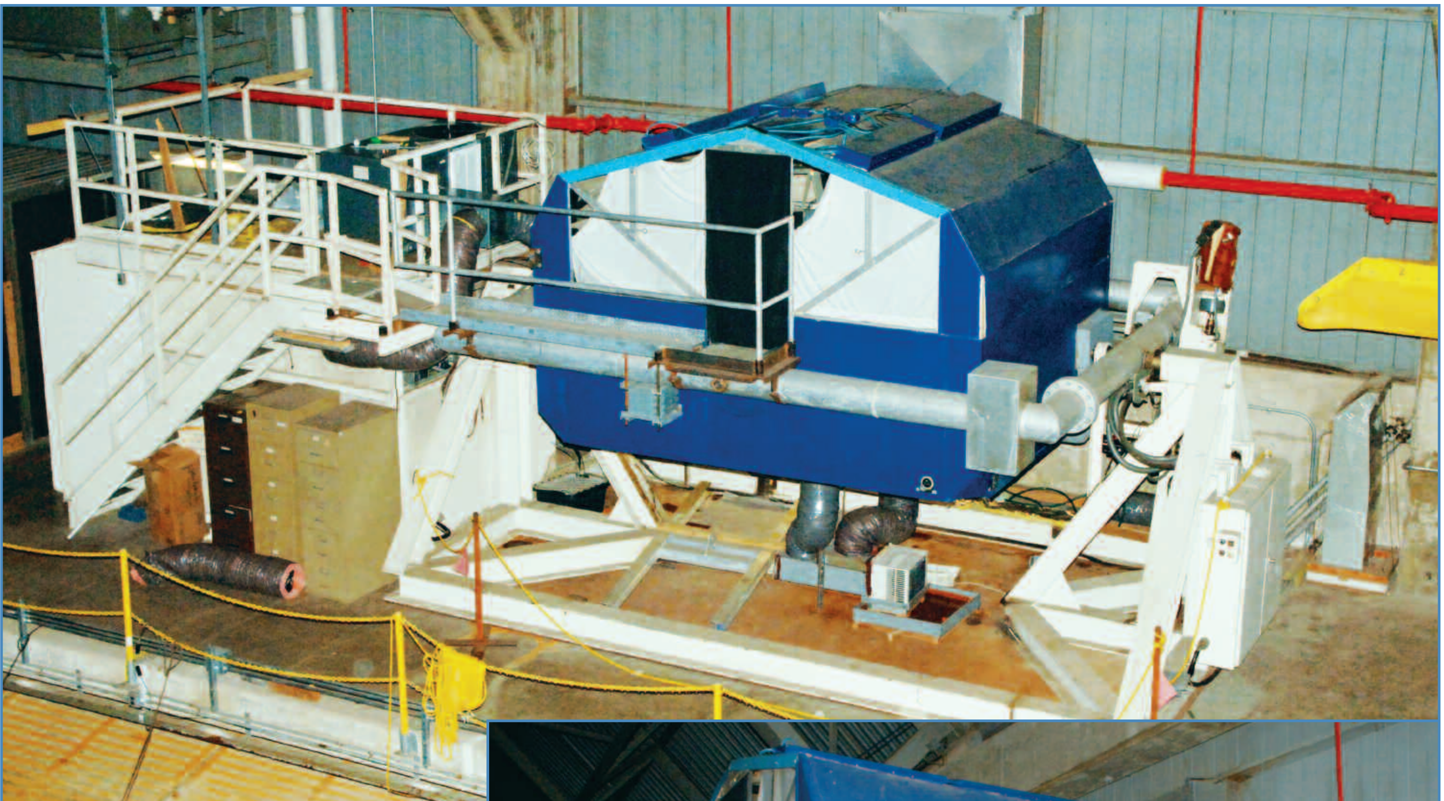
Four years ago, digital maneuvering control systems were installed on *Virginia* Class submarines, to date the most heavily automated of any submarine class. At that time, the unprecedented "fly by wire" systems were a big departure from existing control systems, and had to be incorporated into the ship certification process following the SUBSAFE certification model. After a great collaborative effort between Carderock Division, NAVSEA, industry and other government agencies, the first system was successfully certified to go to sea.

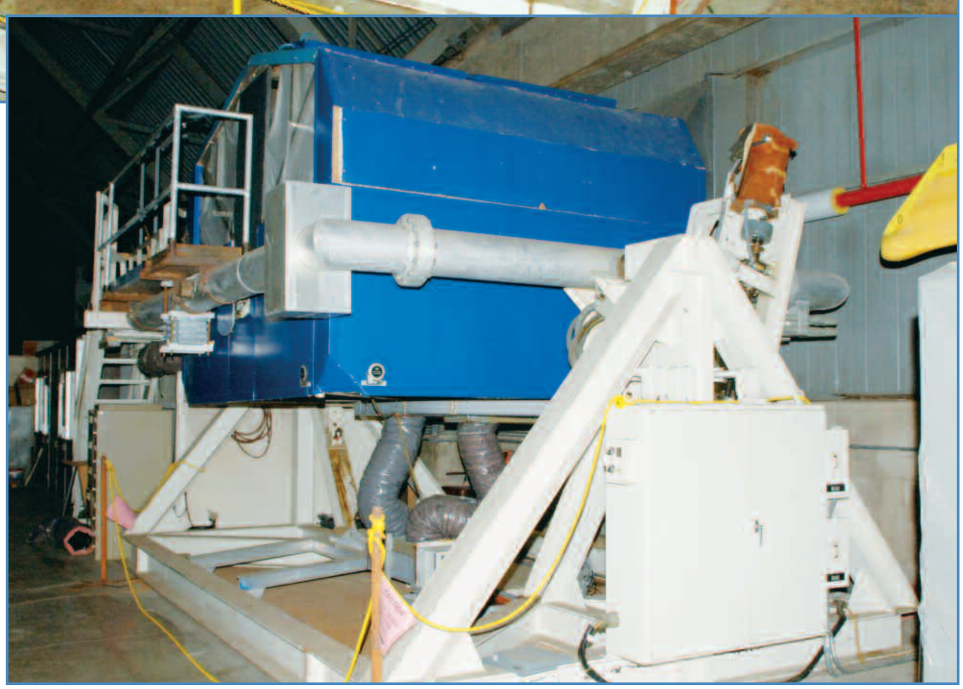
Now that the ground work has been completed, the Division involves itself with maintaining the systems to the same rigorous standard to which they were first certified for use on board submarines. Carderock's Maneuvering and Control Division handles the work, dividing their efforts between software development activities and in-service engineering. Personnel develop the computer software-based algorithms which are used in concert with the onboard hardware to control the rudder, stern planes, bow planes, and seawater flow control valves on the *Virginia* Class boats. Then teams of in-service engineering personnel install the completed tactical software upgrade that includes the control algorithms. Those algorithms are initially provided to a tactical software support activity for integration and test with the entire tactical ship control software build.

Dr. Ed Ammeen, head of the Maneuvering and Control Division, explains that the algorithms have individual control functions, and combine to make up an entire ship control system. "The algorithms we develop," he says, "are like autopilots. The steering and diving algorithm controls the rudder, stern planes and bow planes. The vertical ascent/descent algorithm is included in the hovering depth control system, where you have a ballast-type function, such as during an ice break-through on certain submarines. The *USS Jimmy Carter* (SSN 23) has a low-speed algorithm which coordinates the hovering control system, the secondary propulsion motors, and all the planes. This algorithm is one of the most complex we have ever written." Ammeen adds that steering and diving algorithms are also very complex, because hydrodynamic effects of a submarine operating at a particular speed have to be accounted for in the algorithm, whereas low-speed algorithms are simpler because they only have to account for the mass properties of the vessel. Other algorithms handle the functions of variable ballast and trim, sea direction, sea state, and sea energy estimation, used to quantify the surface suction force imparted on the submarine hull as it nears the surface and calculate ballast and trim compensation required to keep the submarine in trim at current and predicted conditions.

Algorithms are usually written from scratch, but if they already exist, improvements are implemented by generating software change proposals that are reviewed and approved. Those result in changes to the baseline code and supporting documentation. Personnel are required to have all re-written algorithms certified via simulation at a land-based facility, then conduct a trial to validate the functionality of the algorithm. Simulation facilities exist at Carderock's Maneuvering and Seakeeping basin, and at Lockheed Martin facilities in Syracuse, N.Y. and Electric Boat in Groton, Conn. All three facilities use the NSWCCD-developed multivortex simulation as the basis for their certification. The algorithms are written in the Ada programming language, used per a Navy mandate implemented years ago. The algorithms generally have between 1,000 and 3,000 lines of programming code, but can swell to as much as 10,000 lines in the case of the low speed algorithm,

When creating a control algorithm, Ammeen and his team perform hydrodynamic testing using the algorithm to control a small-scale submarine model. Data recorded from these tests are used to develop the full-scale





On this page: Different views of the Motion Base Simulator, located in Carderock Division's Maneuvering and Seakeeping facility. The asset is used to validate fly-by-wire ship control system algorithms and maneuvering simulations. Other simulation facilities for validating algorithms and simulations are at Lockheed Martin Corporation in Syracuse, New York, and at Electric Boat Corporation in Groton, Conn.
Photos by Martin Sheehan, NSWC Carderock Division.

SUBMARINE MANEUVERING (Continued on page 10)

Above left: A ship control panel on an *Ohio* Class vessel.

Above right: Nearer ship is the *USS Virginia* (SSN 774). Farther submarine is *USS Connecticut* (SSN 22). Both ships use ship control algorithms developed by NSWCCD.
U.S. Navy photos.

SUBMARINE MANEUVERING (Continued from page 9)

algorithm, as well as an algorithm which can be used on submarine training simulators. The maneuvering simulation developed by Carderock is used in the tactical test bed to provide a closed loop system to test the performance of the algorithms prior to installation on the submarine. After testing is completed at Carderock, the software is integrated with the rest of the tactical ship control system software at Lockheed Martin or Electric Boat in Groton, Conn., and tested on a tactical representation of the ship control hardware and supporting systems. The final certified tactical SCS software build containing algorithm updates is physically transported on CDs or a circuit card to a dockside facility, where it is loaded to a specially-certified laptop computer that interfaces with onboard printed circuit cards. The laptop then burns the new SCS software build into the ship control processor memory circuit cards to complete the installation.

It takes about six months, from the time an algorithm change is made until it's installed on the ship, for a change in the algorithm to become effective. Institutionalized processes like configuration management and conduct of software safety analyses slow down getting the change in place, but ensure more safety from a programming perspective, and thus more confidence in the change when it goes to sea on the submarine. Ammeen, while interested in shortening the six-month window, is more interested in preserving the safety factor. "We don't have the opportunity to tweak [the algorithm] at sea," he says, "so we have to do as much as we can on land to ensure that it's going to act like it's supposed to at sea." Algorithm changes happen on the order of once every two years.

Ammeen's division provides algorithm development and in-service engineering for *Ohio*, *Seawolf*, and *Virginia* classes of submarines, but no such support exists for *Los Angeles* class ships. Years ago, these boats were outfitted with a fly-by-wire control system compatible with onboard systems. Admiral Hyman G. Rickover decided that the control system, although functioning quite well, detracted from crew training in that they could become complacent and not be effective system monitors. So he ordered the system removed.

Ammeen says the confidence and trust built up around the algorithm development and implementation over the years is very fragile. "It only takes one bad experience," he says, "from the fleet point of view to ruin the work we've done. That's why we're very careful and have institutionalized processes to make sure we don't send an algorithm out there that's going to cause a failure or degradation of performance. We take that pretty seriously."

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Machinery Research & Engineering

Shipboard Launch and Recovery Systems

Moving the Navy from Traditional Systems to Stern Launch Systems

By Walter Nowak, Francis Brennan, and Leslie Spaulding

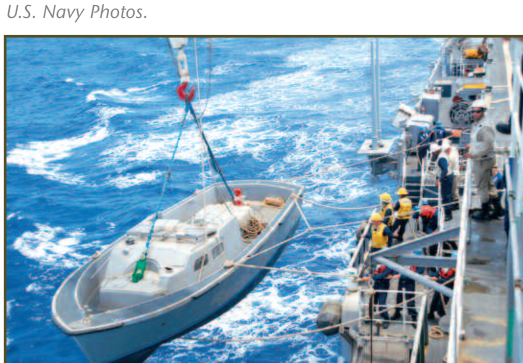
Increasingly, small boats are becoming a mainstay of a ship's ability to meet its mission. Once used almost exclusively for search and rescue (SAR), small boats are now used for anti-terrorism/force protection (AT/FP), visit board search seizure (VBSS), surveillance, special operations, and humanitarian relief. With the growing importance and frequency of small boat use, the importance of the systems to launch and recover them also grows.

U.S. Navy vessels use a variety of over-the-side launch and recovery systems. These are classified as either davits or cranes. All but a few of Navy ships' boats are handled using conventional boat davits. The Navy has continued to refine the design specifications for these davits over the past several years. This required the Navy to change from older style davits based on military specifications to the American Bureau of Shipping/Navy Vessel Rules (ABS/NVR) which is based on more current, commercial/international standards such as the Code of Federal Regulations (CFR), Safety of Life at Sea (SOLAS), and ABS. With this in mind, Carderock Division's in-service engineers have moved from traditional MILSPECS to performance based specifications, thus meeting the ABS/NVR technical requirements for commercial ships and tailoring them to the Navy's needs.

Both changing fleet missions and aging systems have led to modernization and backfit efforts. The FFG 7 Modernization Program was designed to extend the lifespan of this hull class through 2019. These frigates fulfill a protection of shipping mission as anti-submarine warfare combatants for amphibious expeditionary forces, underway replenishment groups, and merchant convoys. Frigate boat davits were obsolete and costly to maintain. A key element of the Modernization Program is replacing these old systems with new, commercial-off-the-shelf boat davits. These new davits provide a quicker, easier way of

RECOVERY SYSTEMS (Continued on page 12)

The majority of small boats are launched/recovered by "over the side" systems, such as cranes (below) and davits (center and right).
U.S. Navy Photos.



RECOVERY SYSTEMS (Continued from page 11)

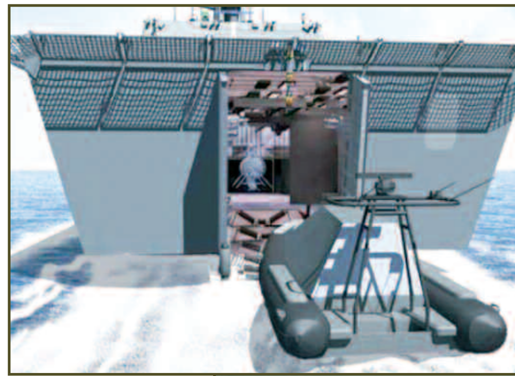
launching and recovering the rigid inflatable boats (RIBs) used to support the extended mission. The engineers at Carderock Division have performed 30 backfits on the FFG 7 Class.

Carderock Division is now turning its attention to the LHA/LHD backfit. These amphibious warships are designed to support the Marine Corps tenets of operational maneuver from the sea and ship to objective maneuver. They sail into harm's way and provide a rapid buildup of combat power ashore in the face of opposition. Because of their inherent capabilities, these ships have been and continue to be called upon to also support humanitarian and other contingency missions on short notice. LHA/LHD davit backfits are required to accommodate the newer, heavier RIBs which were adopted by the U.S. Navy fleet for their speed and versatility. Work will begin this winter and finish with 12 backfits on the LHA/LHD Class. Across all ship classes, the Division's in-service engineers have supported more than 100 davit backfits to provide handling and stowage of the RIBs. As the Navy adopts new boat designs, the boat davits must also evolve to match them.

To support the future fleet, the Navy is committed to developing stern launch and recovery systems on new construction hulls, such as LCS and DDG 1000. Stern launch and recovery systems offer benefits not found with the traditional over-the-side systems. These benefits include quicker launch and recovery, improved personnel safety, and easier launch and recovery of unmanned vehicles. The Navy's technical community is better defining and developing performance and design criteria for these systems to maximize those benefits and reduce the risk to the LCS and DDG 1000 platforms. Currently, the Navy is preparing to conduct demonstration testing of the stern launch and recovery systems on LCS Class, the first on U.S. Navy ships of this size.

The development of new launch and recovery systems is not without its challenges. As the technical demands for launch and recovery systems increase, so does the complexity. With more complex systems and the high crew turnover rate, frequent operator and maintenance training will be required. Extensive training will be required for boat coxswain and ship handling, particularly for stern launch systems. The selected systems and components must reduce shipboard maintenance, yet still provide the desired performance. Complexity of the system must be minimized to enable easy use and maintenance.

Shipboard boat/vehicle launch and recovery systems are essential to complete a ship's mission. As the engineering agent for boat launch and recovery systems, Carderock Division engineers support the systems currently in use in the fleet and are also at the forefront of designing and testing systems on the horizon for new ship construction platforms. In both current and future efforts, in-service engineers are working with Navy other organizations such as Naval Undersea Warfare Center Panama City, and Carderock Division Combatant Craft Division to ensure an integrated approach to the launch and recovery of manned and unmanned vehicle systems.



New Navy stern launch designs, such as the General Dynamics LCS design *(top)* and the Lockheed-Martin LCS design *(bottom)*, use specific performance-based documents.
Images courtesy of General Dynamics and Lockheed Martin.

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Machinery Research & Engineering

Integrated Logistics System

The Tech Authority's Voice in the Fleet

By Leslie Spaulding

Every day the U.S. Navy fleet operates seamlessly. But such operation of the myriad ship systems and components requires much logistical support. The Sailors on the deck can not be expected to know how to maintain, operate, and repair everything. Therefore, products such as technical manuals, planned maintenance system, supply support, and engineering operating support systems provide the necessary technical expertise to keep the ship systems humming. The hull, mechanical, and electrical integrated logistics, which are developed and distributed by the Naval Surface Warfare Center, Carderock Division-Ship Systems Engineering Station (NSWCCD-SSES), draw upon the expertise of the Navy's in-service engineering agents and life cycle managers and serve as the Tech Authority's voice in the fleet.

The integrated logistics support (ILS) provided by NSWCCD-SSES includes:

Engineering Operating Support System (EOSS):
These documents provide step-by-step procedures for how to align and operate the equipment in the fleet. EOSS does not cover every piece of equipment, only the most critical–primarily the propulsion system. The document takes the Sailor through every possible evolution whether it's starting from a completely dead state and bringing everything on line through coming back to the pier, shutting down, and connecting to shore power. These documents are very specific and are tailored to each hull, incorporating the nuances of specific configurations. The EOSS packages are updated every six months to reflect any modifications made to the systems as a result of technical feedbacks.

Planned Maintenance System (PMS):
These documents provide the fleet with information concerning maintenance requirements for ship systems equipment. The PMS covers what maintenance must be done and at what interval. Traditionally, the intervals were based on established timelines; however, in more recent years it has been determined via reliability-centered maintenance.

Sailors aboard *USS Kitty Hawk* use the Engineering Operating Support System to operate the propulsion system.
U.S. Navy photo.

INTEGRATED LOGISTICS SYSTEM (Continued on page 14)

INTEGRATED LOGISTICS SYSTEM (Continued from page 13)

Through this approach systems engineers monitor, assess, and predict how frequently the maintenance should be conducted, saving the fleet both time and money. NSWCCD-SSES updates the PMS quarterly.

Technical Manuals:

The technical manuals found in the fleet provide the Sailors with guidance to troubleshoot, repair and maintain the various ship systems equipment. The manuals contain detailed diagrams and schematics, as well as general overviews of the equipment and theory of operation.

Consolidated Spare Part Allowance List (COSAL):

When hull, mechanical, and electrical equipment is placed in the fleet, the NSWCCD-SSES engineers develop the COSAL. This document lists the equipment or components required for the ship to perform its operational assignment; the repair parts and special tools required for the operation, overhaul, and repair of those equipments; and the miscellaneous portable items necessary for the care and upkeep of the ship.

While the technical manual, planned maintenance system, and engineering operating support system data are maintained within NSWCCD-SSES, the supply support data is maintained at Navy Inventory Control Point, Mechanicsburg, Pa.

A change to any single piece of equipment aboard a ship can impact all logistics documents. When feedback from the fleet is received and changes to equipment or systems are made, the NSWCCD-SSES logistics specialists work with the in-service engineering agents and life cycle managers to ensure these changes are reflected in all pertinent documents through ILS certification. This process helps the Navy ensure that no equipment goes aboard ship that is not properly documented and supported.

In days gone by, ILS was difficult and the products were not at all timely. But with the advent of electronic communication, the coordination has become much more manageable, despite the immense amount of information. The Navy is now moving toward real-time access to information. For example, technical data knowledge management will provide globally deployed fleet users with accurate, complete, configuration-assured, and timely digital technical information to support military missions filtered to the specific user's role and equipment configurations. It replaces a cumbersome and lengthy CD-ROM delivery and library administration process with network centric online electronic distribution. Another area enhanced by electronics is the technical feedback reports. Fleet Sailors provide feedback, which can be incorporated immediately if approved. Of course, the ships still receive paper copies as technology has not reached a point where schematics and instructions can be easily viewed electronically within the shipboard machinery spaces. However, with the electronic data available, the Sailor can print and use only the necessary pages for the job at hand, instead of toting a large manual. Currently, NSWCCD-SSES is researching options for effectively delivering this information directly to the machinery spaces. Another future endeavor involves making these documents truly integrated. The hope is that one day a Sailor would log onto a computer, input the day's assignment, and receive all the pertinent information for that assignment.

The NSWCCD-SSES logisticians provide a link from the NAVSEA technical authority through the life cycle managers and in-service engineers out to the fleet and back again. This role is crucial to ensuring a rigorous, formal engineering process to make sure the equipment is operated as safely, efficiently, and effectively as possible.

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Special Hull Treatment Tile Manufacturing

A Unique Capability Which Supports Our Submarine Fleet

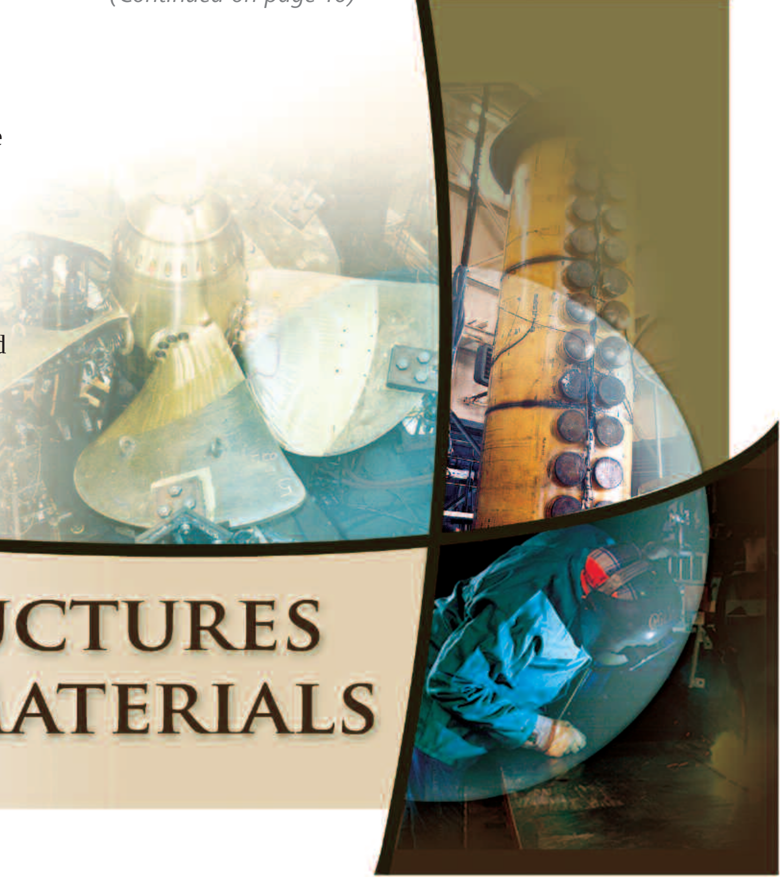
By William Palmer

Submarines in the fleet have used special hull treatment (SHT) tiles for years. Shipyards constructing the boats manufacture enough tiles to cover the entire hull of a submarine, initially. But, during the course of the submarine's life, tiles need to be replaced, and that's where Carderock Division comes into play. Carderock engineers and scientists are the inventors of the formulation that goes into the tiles and have built the equipment to manufacture the tiles. So when replacement tiles are needed Carderock provides. Nonetheless, this comprises a unique manufacturing capability among the warfare centers of the Naval Sea Systems Command. And, as it turns out, this ability meets a very important need critical to submarine repair and shipyard construction efforts.

Since the shipyards manufacture enough tiles to cover the entire hull of a submarine, they will manufacture only what they need, and the cost of making the tiles becomes part of the submarine construction costs. Carderock manufactures the tiles needed for a particular circumstance only, making a limited quantity of tiles to cover a certain shipyard-based evolution or repair. The tiles, once manufactured, are then packaged in boxes, and shipped off to the shipyard where the repair activity is taking place. About eight to ten tiles are processed per day at the Division's West Bethesda site, and the number of tiles produced is limited because of the size of the processing tanks used to formulate the tiles.

Carderock Division came upon the work when the shipyards were looking for suppliers for the tiles. The shipyards queried private suppliers, but none were qualified to manufacture this material or willing to take on the job of manufacturing tiles in small quantities, and Carderock stepped in to take on the work. The shipyards are very appreciative for this timely supply of SHT tiles. The nature of repairs may vary, because tiles may be damaged for various reasons during the course of the submarine's life. Yet, at other times, the tiles may be intact, yet may need to be removed to provide access to the hull for maintenance or hull cuts. In that case, the tiles have to be intentionally destroyed when they are taken off, necessitating their replacement.

SHT TILE MANUFACTURING (Continued on page 16)



SHT TILE MANUFACTURING
(Continued from page 15)

Below: Tile making equipment at Carderock Division's West Bethesda site. This manufacturing ability is a great asset for shipyards, which need the tiles in odd lots to make repairs or accommodate new construction features.

Above: Carderock Division materials engineer Dave Owen processes a tile-making evolution. Other groups and teams help assemble the tiles in kits for shipment to shipyards.
Photos by Harry Friedman, NSWC Carderock Division.

Carderock Division is an important team member shipyards turn to when the Navy's submarines are in their facilities, bringing a much-needed manufacturing capability to bear in effecting repairs and advanced maintenance activities encountered in the shipyard environment.

While the contingent of materials experts at Carderock's West Bethesda site have created the tile formulation and the machinery with which to make it, there are other components of Carderock Division which are also involved in this effort. In-service engineering agents, resident at the Division's Philadelphia site, develop and assemble the repair and seam filler kits for shipment to the shipyards. They also provide packaging and mixing instructions, and training on the use of the kits. In putting the repair kits together, Philadelphia personnel are now transitioning to a packaging supplier to help put the kits together in a manner suitable to the shipyards.

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Environmental Quality Systems

Navy Shipboard Oil Pollution Abatement Systems

Demonstrating and Meeting Reliability, Maintainability, and Reduced Manning Needs for the Present and Future Needs

By Steve Hopko

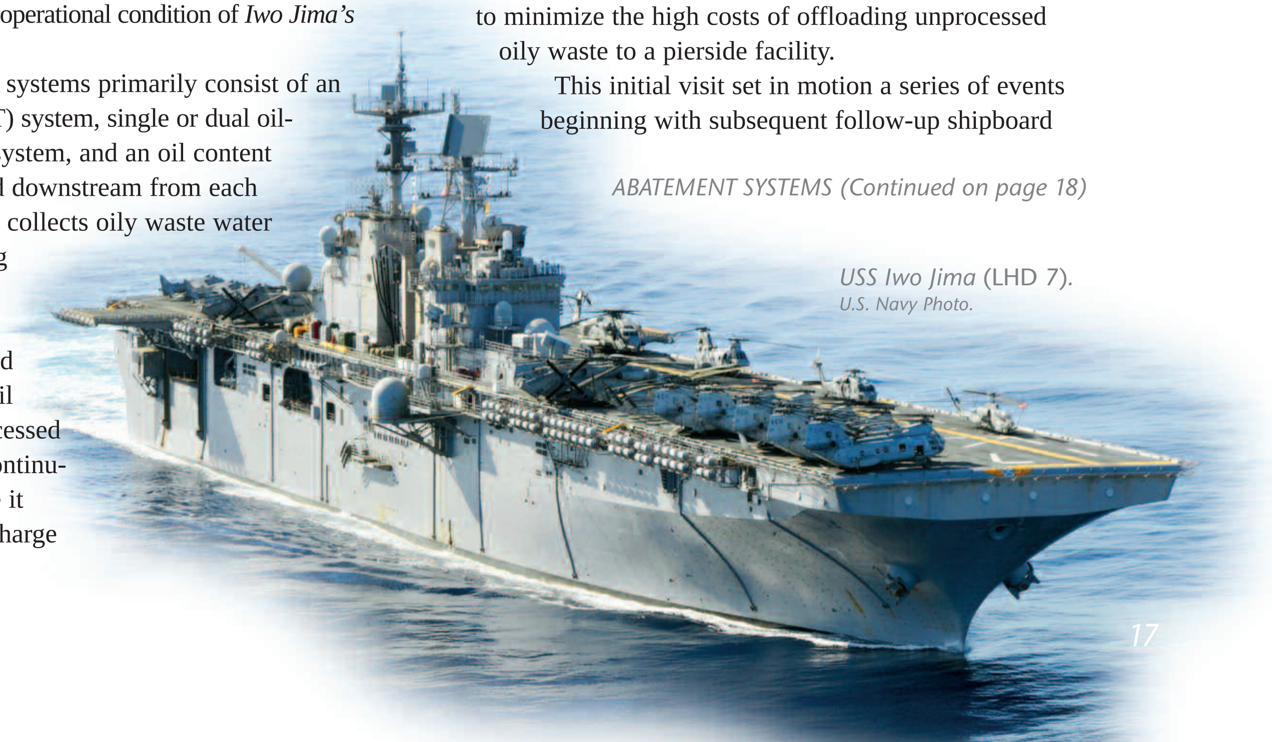
Two unique opportunities presented themselves recently with regard to oil pollution abatement (OPA) systems onboard large deck Navy ships. First, *USS Iwo Jima* (LHD 7) made a rare port appearance on the Delaware River in Philadelphia last fall. Naval Surface Warfare Center, Carderock Division-Ship Systems Engineering Station's (NSWCCD-SSES) office in Philadelphia (also located on the Delaware River) took advantage of this opportunity and made a courtesy visit to check on the material and operational condition of *Iwo Jima's* shipboard OPA system.

Shipboard OPA systems primarily consist of an oily waste transfer (OWT) system, single or dual oil-water separator (OWS) system, and an oil content monitor (OCM) installed downstream from each OWS. The OWT system collects oily waste water from various engineering spaces and discharges it to a tank where the fluid is subsequently processed by an OWS to remove oil from the water. The processed water is then sampled continuously by an OCM where it makes a decision to discharge clean water overboard or recycle unacceptable effluent to be reprocessed. The separated oil is held in a separate tank for pierside offloading.

The courtesy visit paid off as NSWCCD-SSES identified numerous operational problems, excessive corrosion conditions, and design issues associated with the dual, large capacity OWS/OCM systems. These problems prevented the systems from operating as intended or operating at all. Besides safeguarding the environment, it is important that shipboard OPA systems operate reliably to minimize the high costs of offloading unprocessed oily waste to a pierside facility.

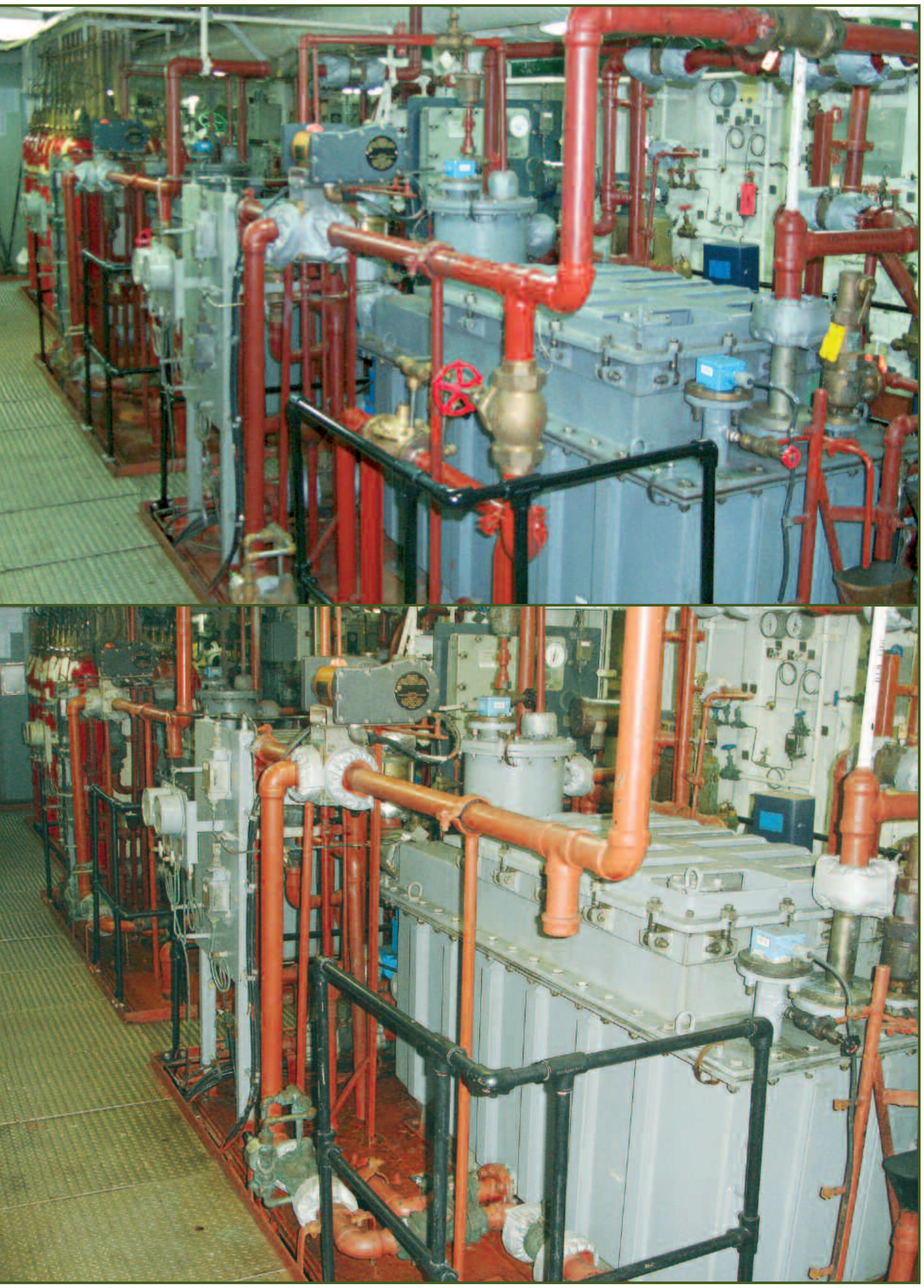
This initial visit set in motion a series of events beginning with subsequent follow-up shipboard

ABATEMENT SYSTEMS (Continued on page 18)



USS Iwo Jima (LHD 7).
U.S. Navy Photo.

ABATEMENT SYSTEMS (Continued from page 17)

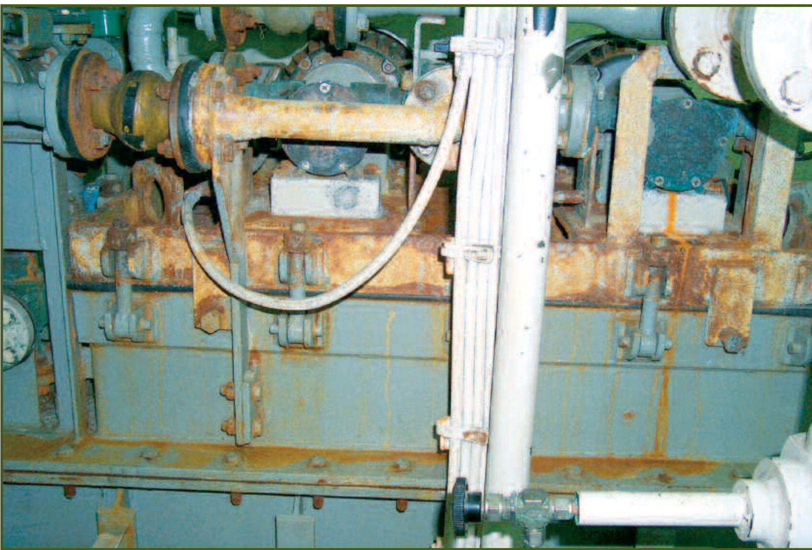


Top: VS-50 OWS system onboard *USS Wasp* (LHD 1) nearly five years ago.
Bottom: VS-50 OWS system onboard *Wasp* today in superb material condition.
Photos by Stephen Hopko, NSWC Carderock Division.

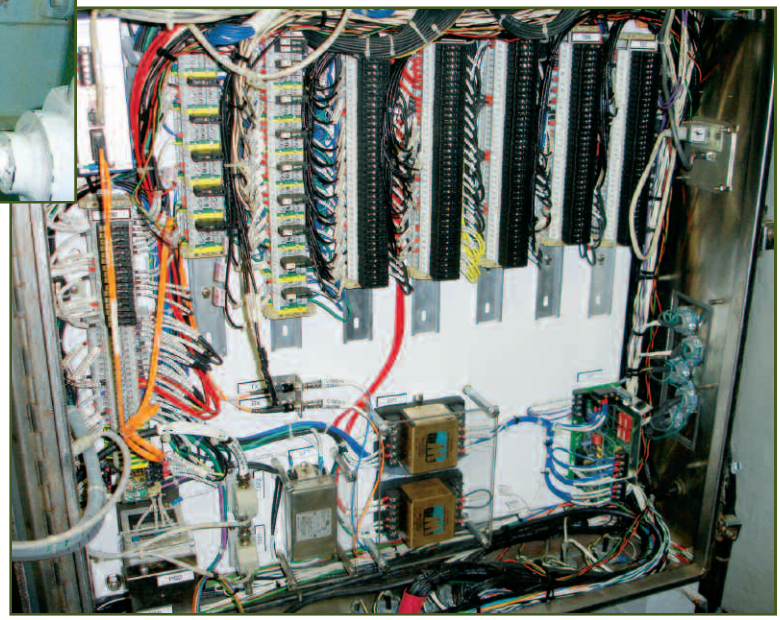
visits by NSWCCD-SSES personnel to LHD 7 at Naval Weapons Station (NWS) Earle, N.J., and at Naval Operations Base (NOB) Norfolk, Va. The inspections and testing conducted during these visits resulted in one of the larger Navy OPA system grooming efforts to date. Through coordination with the Port Engineer for LHD 7, NSWCCD-SSES led an intensive effort to successfully identify, address, and fix all the major issues in time for LHD 7's deployment. This effort required significant financial and contracting resources provided by the Port Engineer, on-hand spare parts provided by NSWCCD-SSES, and the support of the crew. Although less than the high costs of offloading unprocessed oily waste, the overall costs in labor and materials exceeded $225K.

The efforts required to get LHD 7's OPA system into the necessary material and operational condition also played a role in a much larger overall view of Navy shipboard OPA systems. This is where the second unique opportunity presented itself. Six years ago in 2002, one of the two 50 GPM Model C-50 OWS systems onboard LHD 7 was upgraded via a Navy Machinery Alteration (MACHALT) "proof-in" package that addressed many, but not all known issues with the OWS systems typically installed onboard the Navy's larger vessels. Two years later in 2004, the other C-50 OWS onboard LHD 7 received a similar MACHALT conversion. Most fixes associated with the MACHALT were material upgrades that included a few system improvements with the basic system design remaining essentially the same. Five years ago in 2003, a ship in the same class, *USS Wasp* (LHD 1), was upgraded with a comprehensive Ship Alteration (SHIPALT) package (SHIPALT 401K) that addressed most known problems with the Model C-50 OWS. The SHIPALT included major system redesigns, automation upgrades, and new material selections.

The MACHALT modifications made to the Model C-50 OWS at the time were identified as the lower cost, lower impact, interim solution that did not require testing. The SHIPALT redesign of the Model C-50 OWS, which eventually became the Model VS-50 OWS system, was originally designed, developed, and



Left: Example of corrosion severity of C-50 OWS system onboard *USS George Washington* (CVN 73) after four to five years of service.
Below: Internally, the VS-50 OWS control system onboard LHD 1 is like new today.
Photos by Stephen Hopko, NSWC Carderock Division.



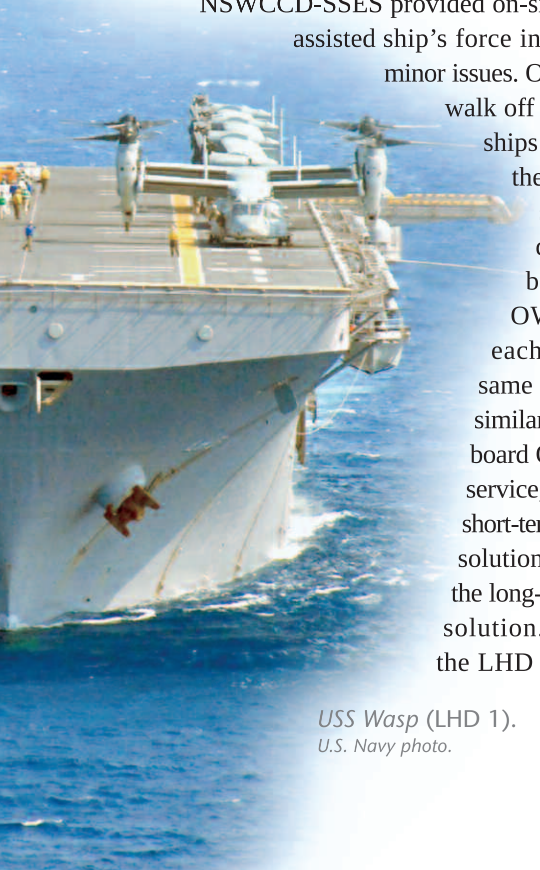
land-based tested at NSWCCD-SSES prior to being installed onboard LHD 1. This was Naval Sea Systems Command's (NAVSEA's) and NSWCCD's response to the fact that no commercial OWS was available to meet the Navy's reliability, maintainability, operability, and performance needs required for these large capacity OWS systems.

As the LHD 7 OPA system grooming and repair effort was underway at NOB Norfolk, LHD 1 happened to be docked at the same pier. NSWCCD-SSES personnel took this opportunity and made a courtesy visit to LHD 1. They found that after five years of shipboard service, over 9,500,000 gallons of oily waste was processed during the course of 4,200 hours of OWS system operation. Just as important, there were no major issues found with the dual VS-50 OWSs onboard LHD 1. The overall system was generally in superb material condition requiring only routine and minor OWS component maintenance and adjustments.

NSWCCD-SSES provided on-site training and assisted ship's force in resolving the minor issues. One could literally walk off one of these two ships and right onto the other ship and see the dramatic difference between both OWS systems, each within the same ship class, with similar lengths of shipboard OWS system service, one with the short-term (MACHALT) solution and one with the long-term (SHIPALT) solution. A check of the LHD 1's 3-M (maintenance and material management) data showed that the ship only had to spend between $4K and $5K for spare parts in a five-year period as opposed to the $225K spent for labor and spare parts to groom LHD 7. Though the MACHALT on LHD 7 was successful, the OWS improvements were overwhelmed by OPA system failures outside the OWS envelope and therefore, beyond the scope of the MACHALT. The findings onboard LHD 1, which has the only VS-50 OWS in the fleet, is good news for *USS Carl Vinson* (CVN 70) since a dual VS-50 OWS system is currently being installed onboard the ship in her refueling complex overhaul (RCOH) at Northrop Grumman Newport News (NGNN).

Because the VS-50 philosophy to provide a reliable system with PLC automation and graphical controls was so successful, NSWCCD-SSES also designed, developed, and land-based tested a prototype automated oily waste transfer (AOWT) system that when combined with the VS-50 system provides an integrated and "smart" automated oil pollution abatement (AOPA) system. The Navy prototype AOPA system is a fully automated, PLC-based "smart system" with graphical touch screens that help facilitate shipboard oily waste monitoring, processing, and management. The AOPA system was designed to significantly reduce operational and maintenance manning requirements and improve overall

ABATEMENT SYSTEMS (Continued on page 20)



USS Wasp (LHD 1).
U.S. Navy photo.

ABATEMENT SYSTEMS (Continued from page 19)

Sailors were pleased with their VS-50 OWS system onboard LHD 1 in 2004.
Photo by Robert Morsa, NSWC Carderock Division.

Sailors are still pleased with their VS-50 OWS system onboard LHD 1 in 2008!
Photo by Stephen Hopko, NSWC Carderock Division.

system efficiency and performance with regard to the effluent quality of the clean water discharged overboard after being processed by primary/secondary treatment systems.

The findings to date indicate that the way forward regarding reliability, maintainability, and automation is to follow the philosophy used in developing the AOPA system. In fact NSWCCD patent counsel has authorized the preparation of patent applications for both the VS-50 and AOWT systems. Since the AOPA system is a Navy-designed system with no commercial manufacturer or vendor for the overall system, a Commercial Research and Development Agreement (CRADA) was established with Naval Automation Group (NAG). With NAG as NSWCCD's CRADA partner, the goal is to provide the resources required to package the modular AOPA system as needed for the U.S. Navy. To keep costs low in today's fiscal environment, NSWCCD's teaming with NAG is a win-win situation. NAG will use its Navy and commercial expertise to apply the successfully implemented principles developed, tested, and fielded by the Navy and integrate these with the most promising commercial systems. This is expected to provide an affordable product that has the benefits and advantages associated with commercial products, while also incorporating the features and materials that, as NSWCCD has identified and proven, will provide a reliable and Sailor-friendly system. The end result will be a relatively low-cost system that reduces oily waste offloading costs, reduces manning and training requirements associated with maintenance and operation, and ultimately preserves a clean aquatic environment.

NSWCCD-SSES personnel received recognition from *USS Iwo Jima* (LHD-7) and an award from the command at NSWCCD-SSES for the efforts provided to improve the OPA system onboard LHD 7. Engineers from NSWCCD were selected and presented a paper titled, *"Fully Integrated, Automated Shipboard Oil Pollution Abatement Systems"* in November 2008 at the Maritime Systems and Technology (MAST) conference that took place in Cadiz, Spain. MAST is an annual global conference and trade-show forum in which future capabilities and concepts are presented, discussed, and debated by the world's leading surface, submarine, and joint operations authorities and enabling technologies.

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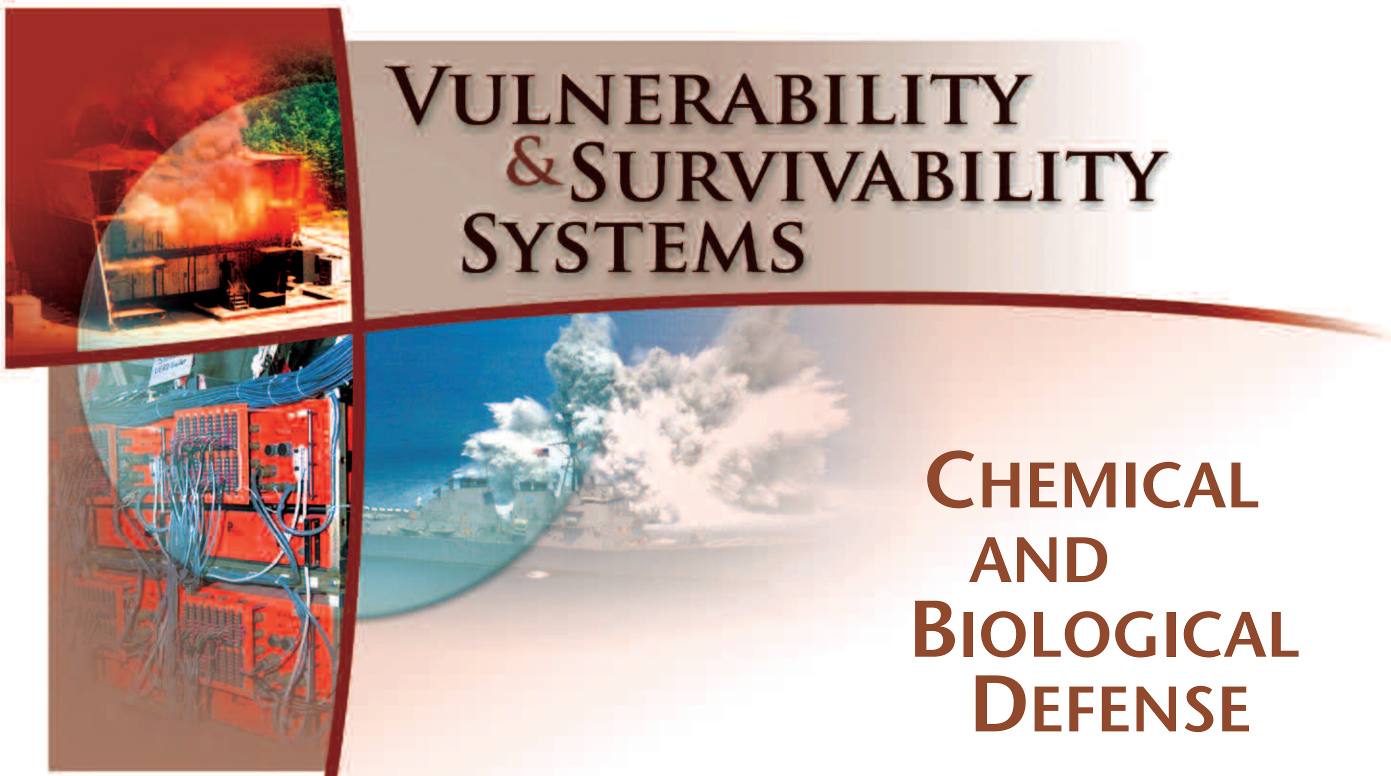

VULNERABILITY & SURVIVABILITY SYSTEMS

CHEMICAL AND BIOLOGICAL DEFENSE

Protecting the Navy's Sailors Against Chemical and Biological Warfare

By Leslie Spaulding

In these troubling times, chemical and biological warfare is a very real threat to all our uniformed service people. These weapons, which can be deployed using aerosol spray, artillery shells, rockets, and ballistic missiles, pose a hazard to our ships and Sailors whether they are homeported, in a host port, or deployed. Although the threat has always been serious, the attack of *USS Cole* (DDG 67) in 2000 and the 9/11 bombings in New York City and Washington, D.C., in 2001 emphasized the urgency for ensuring our Sailors are protected from the effects of these insidious weapons. While neither incident involved chemical and biological weapons, they demonstrated that our foes can get close enough to do irreparable harm.

Of course, the first line of defense in protecting our fleet Sailors is to deter chemical and biological weapons. However, if an attack occurs, the second line of defense is proper chemical and biological defense (CBD) individual protective equipment (IPE). In 2002, the Navy focused on this issue through a CBD readiness improvement program (RIP). As the in-service engineering agent for CBD equipment, NSWCCD-SSES conducted inspections aboard Navy ships to determine the state of readiness for this equipment. "During the initial inspections, we found that the CBD equipment in the fleet was in need of refurbishment, replacement, and proper stowage," explained Carderock Division's Robert Sadwick, a former Navy damage control assistant, who conducted the inspections. "Due to poor stowage, the equipment was in bad condition. We offloaded all the gear and carefully inspected it, repairing what we could and replacing what we couldn't." Further complicating the situation was the fact that CBD equipment has a shelf life, and many of the canisters and suits found in the fleet had expired.

Under this program, the Navy had three urgent fleet requirements:

(1) provide an automated CBD equipment inventory management system because no control system for gear existed,

(2) ensure each Sailor had a serviceable, properly fitted protective mask by fielding a protective mask tester for each ship to ensure proper fit, and

BIOLOGICAL DEFENSE (Continued on page 22)

BIOLOGICAL DEFENSE (Continued from page 21)

Through the chemical and biological defense readiness improvement program:

Individual protective equipment is sorted.

Before being packed, the individual protective equipment is bar coded and the information is entered into an inventory management system.

Sailors are sized for the individual protective equipment, and that information is entered into an inventory management system.

A sailor is fit-tested for his protective mask.

The equipment is kitted and returned to the ship.

Photos this page provided by J. Naylor, NSWC Carderock Division.

(3) ensure ready access to CBD IPE via an individually designed kit bag.

This RIP ended in 2005. However, a new program, the CBD RIP Lean, began in November 2007 under the direction of program manager Mike Carl, NSWC Panama City. This program streamlined the Navy's process for supplying CBD IPE kits. Instead of teams going out to ships to personally fit each Sailor, the distribution of these kits is centrally managed by the Consolidated Storage Facility (CSF) in Fort Worth, Texas. "This change was necessitated by funding constraints," explained CBD in-service engineering agent John Naylor. "Fitting each ship individually was costly. We had to find a better way of effectively and efficiently providing the fleet with protective equipment." NSWCCD-SSES revised IPE PMS documents to correspond with the transition of inspection and inventory tasks to the Consolidated Storage Facility, so ships will not normally have to perform maintenance on CBD equipment.

A typical shipboard kit bag containing a JSLIST suit, gloves, boots, a canteen, a web belt, and two filtering canisters.

The resulting CBD IPE RIP Lean program ensures minimum IPE readiness levels are achieved through issuing of CBD masks and IPE kits periodically, based upon Fleet Response Plan Cycles and Sailor rotations. Working with SUPSHIPs and the supply system, NSWCCD-SSES coordinates the initial outfitting process with RIP-Lean fitting/kitting prior to a ship's first deployment instead of purchasing and storing CBR-D IPE in SUPSHIP warehouses. The process of fitting a ship begins up to 120 days before deployment. CSF Fort Worth maintains the inventory management system, which allows the IPE and shelf life to be managed and tracked. Additionally, the IPE allowance equipage list (AEL) was revised to combine ensemble

A typical expeditionary force kit backpack, containing similar equipment modified to fit mission needs.

Individual protective equipment is identified using laser etching.

Ships awaiting the RIP-L at Pearl Harbor.

Photos this page provided by J. Naylor, NSWC Carderock Division.

components into generic sized kits and to reflect outfitting to actual COB or BA as determined during the fitting process instead of to the maximum manning for the ship.

As the in-service engineering agent, NSWCCD-SSES leads a contractor team in conducting the Readiness Improvement Program-Lean visits. During these visits the Sailors are measured and assigned one of seven standard fleet kit bags. These fleet kit bags contain a Joint Service Lightweight Suit Technology (JSLIST) suit, boots, gloves, a canteen, a web belt, and two filter canisters for the mask. Note that the masks, which are carried separately outside the fleet kit bags, vary according to mission needs. The Sailors aboard amphibious ships receive a double kitted bag in the event they must go ashore. "We found that these seven standard sizes fit most of the Sailors (92%)," explained Naylor. "However, we were still individually fitting the remaining crew members, so we've expanded the standard kits to nine sizes, which will help us fit about 98% of our Sailors." In addition to the fleet kit bags, the Sailors also receive decontamination kits, which are stored at shipboard decontamination stations. Storage of the fleet kit bags is still a challenge, as shipboard space is at a premium. Ship commanders determine threat levels. The fleet kit bags are distributed when a threat is imminent.

In addition to Navy ships, this RIP Lean program also services the Naval Expeditionary Combat Command, and Navy individual augmentees, which receive kitted backpacks or expeditionary bags instead of fleet kit bags. The backpacks contain the same equipment but they carry different masks to accommodate various mission needs. Fleet hospitals are also supported, receiving similar kit bags as the rest of the fleet.

Since 2002, the Navy has come a long way in ensuring our Sailors are protected from the effects of chemical and biological agents. Through streamlining the sizing process, establishing the inventory management system, and tailoring the kits to the mission, the Navy has improved fleet readiness levels.

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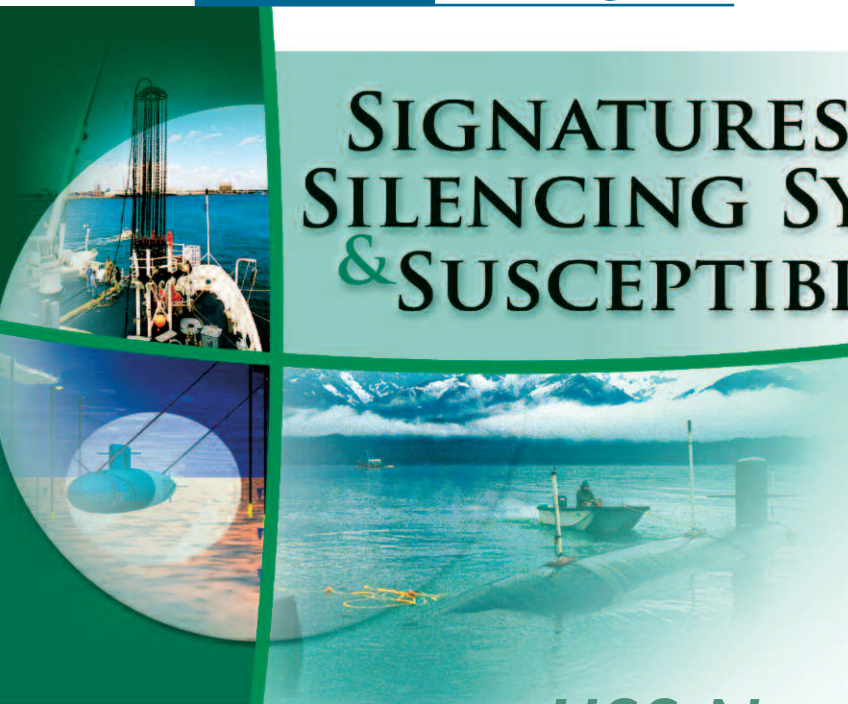


Signatures, Silencing Systems, & Susceptibility

USS New Orleans (LPD 18) Advanced Degaussing System Calibration

Calibration Team Succeeds Despite Challenges at a Calibration Range Facility

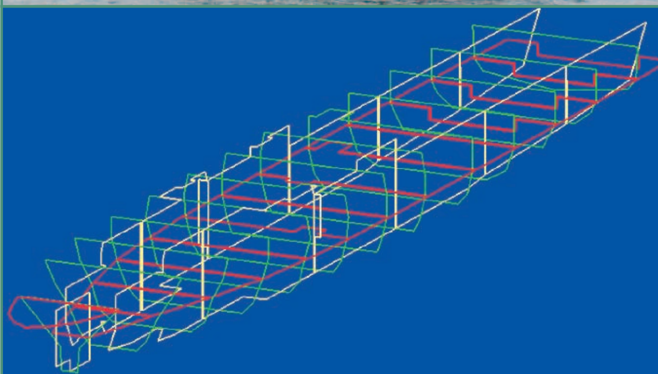
By William H. Gay

Personnel from the Underwater Electromagnetic Signatures and Technology Division successfully calibrated the Advanced Degaussing System (ADS) of the *USS New Orleans* (LPD 18) in San Diego, Calif. on November 24, 2008. The *New Orleans* is the second ship in the *San Antonio* Class of amphibious assault ships. This class is equipped with an advanced degaussing system which confers world-class magnetic signature control. The degaussing system is comprised of numerous independent onboard current-carrying coils. The individual currents can be tuned to produce complex magnetic fields. The purpose of calibration is to adjust the degaussing system settings in order to oppose ship magnetic signature, thereby minimizing the ship's residual magnetic signature and in the process reducing susceptibility to magnetic influence mines.

Typically, ADS calibration is conducted in two phases. In Phase 1, the ship is moored at a deperming facility. Phase 2 involves a series of ship transits across a magnetic measurement range located on the seabed of the San Diego harbor entrance channel. During Phase 1, the ship first undergoes magnetic treatment in order to remove signature anomalies, resulting in a stable magnetic state. Then the ship's undegaussed magnetic signature components are measured using the deperming facility's grid of underwater magnetic sensors. The fields produced by the individual degaussing coils are also measured. Mathematical models of the ship's magnetic signatures and the degaussing system are then constructed. Finally, the degaussing coils are used to minimize ship signature components. Phase 2 is conducted in order to check and optimize the Phase 1 settings, and to degauss any signature components that could not be isolated and minimized in the deperming slip.

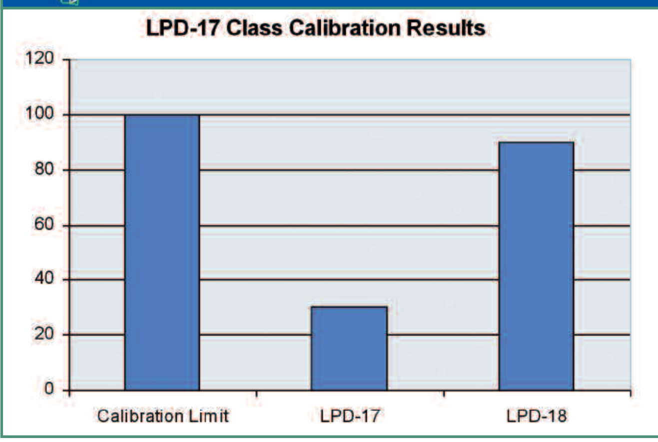
The calibration of *USS New Orleans* was complicated by the fact that the San Diego Deperming Facility was not available due to an ongoing upgrade. This provided several challenges to the calibration team. First, the ship had an anomalous post-construction magnetic signature that could not be smoothed without a deperming event. Second, the inability to make comprehensive degaussing coil effects measurements in the deperming slip resulted

Left: The *USS New Orleans* (LPD 18) northbound approaching the San Diego magnetic range.



Middle left: Depiction of the arrangement of the three sets of degaussing coils on the *New Orleans*.

Above: Aerial view of the San Diego Magnetic Silencing Facility. The image shows the perpendicular approach and Williamson turn features of the range runs.



Left: This graph shows that the lack of Phase I correction adversely impacts final degaussing performance.

Images this page courtesy of William H. Gay, NSWC Carderock Division.

in the inability to optimize the degaussing system model used for range calibration. Third, the limited number of measurements available in Phase 2 placed a constraint on the number of adjustments that could be made to the system. Overall, the calibration was riskier than is typical due to the faster pace and degraded analysis capabilities.

The risk was reduced to some extent by using the optimized coil system model and some signature components from the *USS San Antonio* (LPD 17) calibration trial in generating the initial LPD 18 calibration settings. Due to the high degree of similarity between the two ships, approximate calibration settings for all components of the LPD 18 magnetic signature, aside from the post-construction anomalies, were established prior to the range evolution. The risk was also reduced via a series of ship checks to verify individual degaussing coil polarity and ampacity, and via the pre-trial analysis of undegaussed range measurements used to study signature anomalies.

The calibration team filled both shore and ship-based duty stations during the trial. The shoreside team was located in the San Diego Magnetic Silencing Facility (MSF) range house. MSF personnel performed magnetic data acquisition. The shoreside team performed signature analysis, calibration adjustment computation and communication with the onboard team. The onboard team performed trial direction, degaussing system update, navigation aid, interface with ship's personnel and communication with the shoreside team. Communications included voice, file transfer and GPS ship tracking data. The GPS tracking system was installed several days prior to the Nov. 24 range calibration, and was tested along with the ship-shore communications system.

The calibration itself consisted of repeated transits over the magnetic measurement range. Twelve runs were accomplished in five hours, for an average of approximately 30 minutes per run. This evolution put a great deal of stress on the ship due to the quantity and proximity of numerous commercial and recreational vessels using the harbor channel, and the need to execute turns in shoal water with limited room to maneuver. Despite these difficulties LPD 18 was able to make the center of the measurement array on all runs, providing excellent signature data for analysis.

SYSTEM CALIBRATION (Continued on page 26)

SYSTEM CALIBRATION (Continued from page 25)

The LPD 18 was degaussed to satisfactory levels in an iterative process. The partially degaussed signature was measured. The raw magnetic data was then merged with GPS tracking data to precisely locate the ship and its degaussing coils relative to the measured signature. The track-merged data was then analyzed, simulated degaussing was performed, and optimal calibration adjustments were computed. The adjustments were transmitted to the onboard team for installation into the advanced degaussing controller. Subsequent runs were then conducted to gauge the degree of signature improvement and to determine if further adjustment was required.

The final degaussed signature was below the magnetic signature limit specified in OPNAVINST 8950.2G. It was not as low as this class of ship can achieve, as demonstrated in the calibration of the LPD 17, due to the lack of a deperming evolution to smooth the signature, the lack of comprehensive degaussing system characterization measurements, and the limited number of range runs. Nevertheless, the signature limit was met and the trial was successful due to the hard work, creativity and attention to detail exhibited by the calibration team, MSF San Diego personnel, and the LPD 18 crew.

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TECHNOLOGY & INNOVATION

Metal Matrix Composites

Providing Strong Material with Extraordinary Wear Characteristics

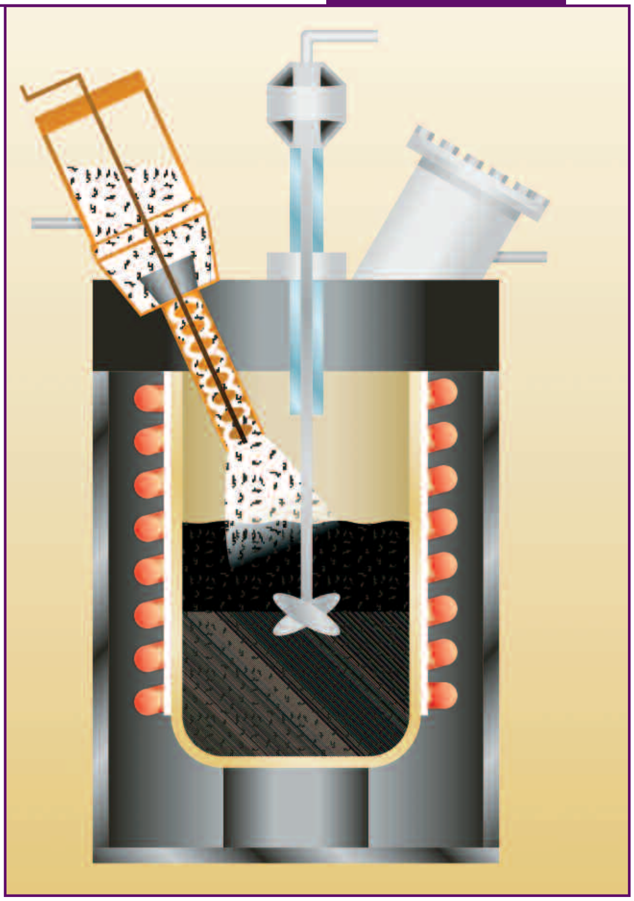
By William Palmer

Classically, metal matrix composites (MMCs) are composed of two or more judiciously chosen materials that can be tailored to provide a unique combination of strength, stiffness and tribological properties. With support from the Office of Naval Research, material scientists at Naval Surface Warfare Center, Carderock Division, have synthesized metal matrix and ceramic particle combinations to vastly improve resistance to wear while simultaneously eliminating asbestos in selected applications.

In the makeup of MMCs, a basic metal is “saturated” with a dispersion of hard, ceramic reinforcement material that is compatible with the metal, and which takes advantage of the best properties of both the metal and the reinforcement. The reinforcement material can take the form of particles, fibers, or any material which can be added to the metal and not react chemically with the metal.

One fleetside application has used MMC material in a winch drum used as part of the Underway Replenishment (UNREP) transport system used to move supplies and cargo among Navy ships at sea. The drum has an internal air brake which used asbestos pads to provide the frictional force to stop the drum. A drum made of aluminum bronze reinforced with titanium carbide (chemical formula of TiC) particles has proven to have superior wear characteristics. The process by which the bronze and titanium carbide are combined was created by Amarnath Divecha, a Carderock Division materials engineer with 23 patents related to MMC technology, in concert with engineers at NSWC, Port Hueneme Division. The Bronze/TiC MMC was successfully tested in the winch drum assembly on the *USNS Kilauea* (AE 26) enabling elimination of carcinogenic asbestos shoes. Equally important, the drum also exhibits very little wear after at sea, long term tests.

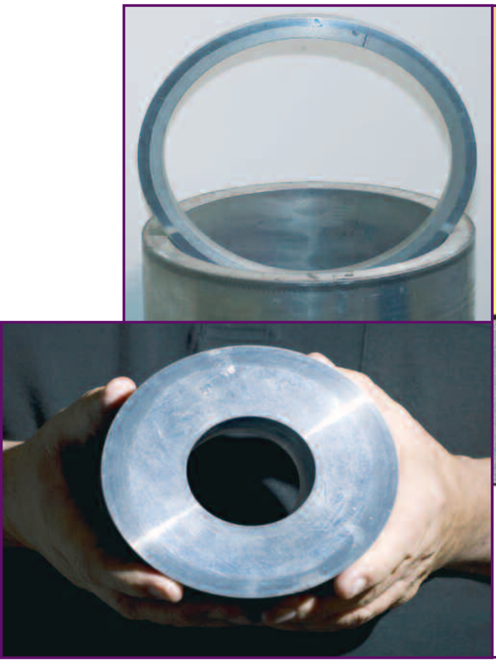
Divecha and his colleagues used a 150-year-old metallurgy process called centrifugal casting to combine the bronze and titanium carbide in manufacturing the winch drum. Using the centrifugal casting process, the TiC particles are added to molten bronze, stirred, and then poured into a rotating mold. Since TiC, with a density of 4.9 grams per cubic centimeter, is lighter than bronze, which has a density of 7.5 grams per cubic centimeter, the centrifugal force created by the rotation of the mold separates the two components, such that the lighter TiC accumulates *en masse* at the inner diameter of the mold during casting, which is exactly where friction is applied to the drum and where extra wear resistance is needed. Subsequent wear tests showed that the drum operated for 10,000 hours without any evidence of wear.

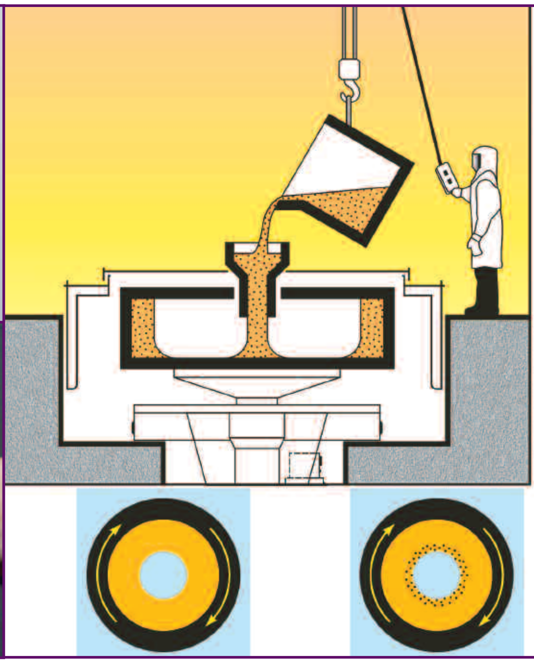


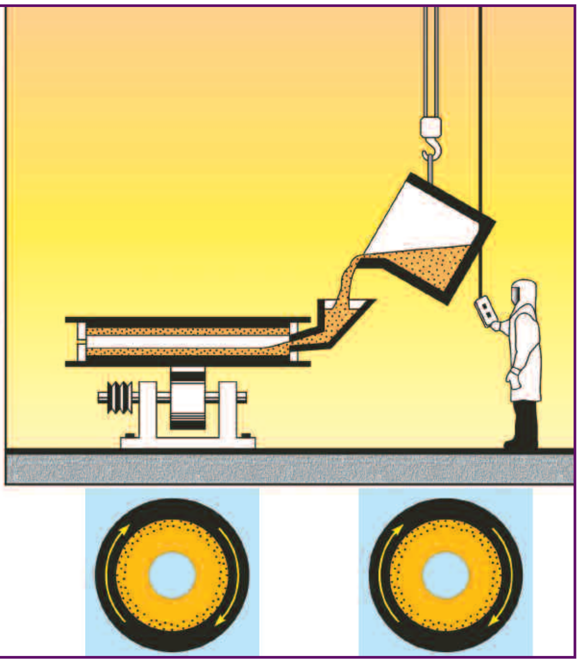
Below: These two specimens show the division in material which can be achieved in centrifugal casting. The process uses centrifugal force to separate heavier and lighter particles, so the formulation of the metal matrix composite can be concentrated in one area of the specimen.
Photos by Bill Boston, NSWC Carderock Division.

Above graphic: In this typical casting, the base metal is heated and melted by an induction heater. The reinforcement particles are dispensed via a hopper into the molten matrix from the entry point at upper left. The mix is stirred by an air motor driving an impeller (center). A viewing port is at upper right.

Left graphic: This illustration shows the arrangement of a vertical centrifugal casting.
Right graphic: This shows how a horizontal centrifugal casting is typically laid out. This casting is used in making long lengths of pipe.
Graphic images provided by Amarnath Divecha, NSWC Carderock Division.

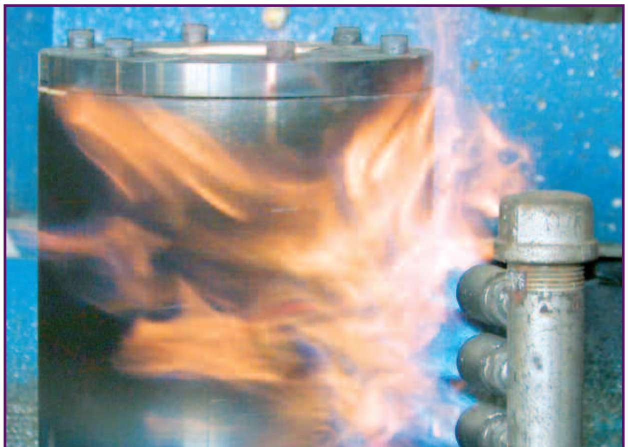






MATRIX COMPOSITIES (Continued on page 28)

PROPULSION SYSTEM *(Continued from page 31)*



Another application involved using bronze with tungsten carbide, which has a chemical formula of WC. The bronze and WC particles were combined in the same way, except that gravity was used to move the heavier WC particles to the bottom of a mold. This WC/ Bronze MMC is being considered for use in ship shaft seal applications. The wear resistance exhibited by a WC/Bronze MMC, as measured by Wartsila, a shaft seal original equipment manufacturer, is outstanding. Using WC/Bronze, the life of the seal can be extended substantially, from four to at least 12 years. Shaft seal material using the WC/Bronze material is currently undergoing testing.

Judicious combining of different materials can result in synergy, taking advantage of strength, modulus, corrosion and wear resistance of each component of the MMC and paying big dividends in the fleet, Carderock Division's ultimate customer. Solving fleet problems using expertise in materials is one way Carderock Division is helping our Navy customers meet their missions.

Top left: A centrifugal casting mold is heated by direct flame prior to pouring of the metal matrix composite "melt."

Left: A mold release compound is sprayed around the central hole of the mold. The compound facilitates casting removal.

Left: Scott Hoover, left, handling the molten base metal, dispenses reinforcement particles into the crucible. Dr. Bill Ferrando uses a mallet to ensure all reinforcement powder goes into the crucible.

Bottom: Next in the process, Hoover pours the molten material, heated to between 1200 and 1300 degrees centigrade in the crucible, into the heated rotating mold.
Images provided by Bill Boston, NSWC Carderock Division.

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Signatures, Silencing Systems, & Susceptibility

This core equity specializes in research, development, design, testing, acquisition support, fleet guidance and training, and in-service engineering for signatures on ships and ship systems for all current and future Navy ships and seaborne vehicles and their component systems and assigned personnel.

Structures & Materials

This core equity provides the Navy with specialized facilities and expertise for the full spectrum of research, development, design, testing, acquisition support, and in-service engineering in the area of materials and structures.


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